wherein the metal oxide is present in an amount more than about 0.1 weight percent of the metal particles, and

wherein the metal oxide is present in an amount less than about 10 weight percent of the metal particles.

30. The ceramic heater according to claim 4,

wherein the metal particles have an average particle size of about 0.1 to 100 μm, and

wherein the metal particles are flaked-shaped particles or a mixture of spherical particles and flake-shaped particles.

31. The ceramic heater according to claim 4, wherein the heating body comprises tungsten, molybdenum, tungsten carbide or molybdenum carbide.

32. The ceramic heater according to claim 5, wherein the noble metal is at least one of gold, silver, platinum and palladium.

33. A ceramic heater for heating a semiconductor wafer comprising:

a disc-shaped ceramic substrate made of nitride ceramic or carbide ceramic,

a heating body formed on a surface of the disc-shaped ceramic substrate, and

a surface opposite the surface having the heating body being a heating surface.---

REMARKS

Reconsideration and withdrawal of the rejection of record are respectively requested.

Summary of Status of Amendments and Office Action

Upon the entry of the above amendment, claims 1, 3 to 5, 7 and 14 to 16 will have been amended and claims 25 to 33 will have been added. Accordingly, claims 1 to 33 will be pending in

the application, with claims 2 and 8 to 24 being directed to a non-elected invention. Claims 1, 3 to 7 and 25 to 33 are subject to examination with claims 1, and 33 being independent.

In the Office Action, claim 5 is rejected under 35 U.S.C. § 112, second paragraph; claims 1 and 3 - 6 are rejected under 35 U.S.C. § 102(b); and claim 7 is rejected under 35 U.S.C. § 103(a).

Request for Rejoinder of Method Claims 14 to 16

In the Office Action, the Examiner made the Restriction Requirement final.

Applicants respectfully submit that since claim 1, directed to a ceramic heater, is now in condition for allowance for the reasons submitted below, in accordance with MPEP § 821.04, the Examiner should rejoin method of making claims 14 to 16, which now include all the limitations of the ceramic heater of claim 1.

For the foregoing reason, Applicants request that the Examiner rejoin method claims 14 to 16 and indicate their allowability.

Amended Claims 1, 3 to 5, 7 and 14 to 16 and Newly Added Claims 25 to 39

Applicants submit that no new matter is being added in the present application and that amended claims 1, 3 to 5 and 7 and the newly added claims contain recitations which are supported by the specification as follows:

Claim 1 has been further amended to recite that the ceramic substrate is disc-shaped. Support for this recitation can be found in the disclosure, *inter alia*, at page 8, lines 13 to 17, page 9, lines 13 to 15 and page 26, the last line.

Claims 3 to 5 and 7 have been amended to conform them to US practice. In this regard, claims 3 and 4 have been amended to recite that the heating body comprises, instead of being formed

of, a sintered body of metal particles. The Examiner will note that in the examples, such as example 4 on page 29, the sintered body is made from a conductive paste having (comprising) acrylic binder. Further, claim 5 has been amended to provide antecedent support for the term "metal particles".

Claims 14 to 16 have been amended to conform them to US practice and to include all the limitations of ceramic heater claim 1.

Claim 25 recites that the aspect ratio is about 50 to 5,000. Support for this recitation can be found in the specification at least at page 13, line 17.

Claim 26 recites that the nitride ceramic is at least one metal nitride ceramic comprising aluminum nitride, silicon nitride or titanium nitride and that the carbide ceramic is at least one metal carbide ceramic comprising silicon carbide, zirconium carbide, titanium carbide, or tungsten carbide. Support for these recitations can be found in the specification at least at page 11, lines 1 to 10.

Claim 27 recites that the substrate has a thickness of about 0.5 to 5 mm and that the heating body has a thickness of about 1 to 50 μm. Support for these recitations can be found in the specification at least at page 10, lines 25 and 26 and at page 12, lines 1 to 3.

Claim 28 recites that the heating body has a thickness of about 1 to 10 μm. Support for this recitation can be found in the specification at least at page 19, lines 7 to 9.

Claim 29 recites that the metal oxide is one or more of lead oxide, zinc oxide, silicon oxide, boron oxide, aluminum oxide, yttrium oxide and titanium oxide, that the metal oxide is present in an amount more than about than 0.1 weight percent of the metal particles, and that the metal oxide is present in an amount less than about 10 weight percent of the metal particles. Support for these recitations can be found in the specification at least at page 17, lines 14 to 23.

Claim 30 recites that the metal particles have an average particle size of about 0.1 to 100 μm and that the metal particles are flaked -shaped particles or a mixture of spherical particles and flake-shaped particles. Support for these recitations can be found in the specification at least at page 16, lines 9 to 17.

Claim 31 recites that the heating body comprises tungsten, molybdenum, tungsten carbide or molybdenum carbide. Support for this recitation can be found in the specification at least at page 5, lines 5 to 7.

Claim 32 recites that the noble metal is one or more of gold, silver, platinum or palladium. Support for this recitation can be found in the specification at least at page 16, lines 1 to 4.

Independent claim 33 includes all the recitations of claim 1 and further recites that the ceramic heater is used for heating a semiconductor wafer. Support for the latter recitation appears in the disclosure at least at page 1, lines 2 to 8.

Response to the Rejection of Claim 5 Under 35 U.S.C. § 112, Second Paragraph

The Office Action has rejected claim 5 under 35 U.S.C. § 112, second paragraph, as being indefinite, since there is no proper antecedent support for "the metal particles".

Claim 5 has been amended to depend from claim 3, thus overcoming the instant rejection.

For the foregoing reasons, Applicants request that the Examiner withdraw the rejection.

Response to the Rejection of Claims 1 and 3- 6 under 35 U.S.C. § 102(b)

The Office Action has rejected claims 1 and 3 - 6 under 35 U.S.C. § 102(b) as being clearly anticipated by Okuda et al. (U.S. Patent No. 4,804,823).

The present remarks apply to claims 1 and 3 to 6, to newly added claims 25 to 33 and to amended method claims 14 to 16.

Applicants have amended claim 1 to further recite that the ceramic substrate is disc-shaped. Since Okuda et al. do not teach that the ceramic substrate is disc-shaped, Okuda et al. cannot anticipate the present claims, all of which now recite that the ceramic substrate is disc-shaped.

Applicants direct the Examiner's attention to Okuda et al., Figs. 2, 3 and 5, which disclose only a quadrangle-shaped heater, and not a disc-shaped heater, as recited in the present claims. Further, the Examiner will note that Okuda et al. column 1, lines 5 to 10, disclose that the heater can be widely used for ordinary houses, electronic parts, industrial equipments and automobiles. The ordinary house heater is fundamentally quadrangle in shape as seen from petroleum fan heater, air conditioner and the like. Further, the electronic parts, printed wiring boards, and LSI are fundamentally quadrangle in shape. Thus, it can be seen that the heater of Okuda et al. is quadrangle shaped.

For the foregoing reason, Applicants request that the Examiner withdraw the rejection.

Response to the Rejection of Claim 7 under 35 U.S.C. § 103(a)

The Office Action rejects claim 7 under 35 U.S.C. § 103(a) as being unpatentable over Okuda et al. (U.S. Patent No. 4,804,823). The Examiner states that Okuda et al. disclose all the structure claimed including an aluminum nitride substrate, a heating body composed of a sintered body of metal particles such as TiN and a metal oxide such as alumina or magnesia or metal particles such as tungsten carbide, and a non-oxidizing metal layer such as Ni covering the heating body (see column 7, lines 16-22). The Examiner acknowledges that Okuda et al. do not show that the heating

body has a sectional shape of the claimed ratio, but that Okuda et al. teach that the sectional area and length of the heat generating resistor layer are changed according to the desired resistance value (see column 5, lines 1-3). The Examiner concludes that it would have been obvious to one of ordinary skill in the art to change the ratio of the sectional area within the claimed range to achieve the desired resistance value for generating a desired heating temperature.

Applicants respectfully disagree with the Examiner's position. The present remarks apply to claim 7, to newly added claims 25 to 33 and to amended method claims 14 to 16.

Applicants respectfully submit that the Examiner has not established a prima facie case of obviousness. Okuda et al. do not render obvious the present claimed invention.

In this regard, the present claims recite that the heater comprises a **disc-shaped** ceramic substrate. Applicants respectfully submit that Okuda et al. do not teach or suggest that the heater disclosed in their patent comprises a **disc-shaped** ceramic substrate. In fact, Applicants submit that Okuda et al. teach away from using such a shape, since Okuda et al. utilize heaters having a conventional shape, i.e., a quadrangle shape. See, for example Figs. 2, 3, and 5. In addition, claims 7 and 38 further recite that the heating body has an aspect ratio of about 10 to 10,000 and claim 25 further recites that the heating body has an aspect ratio of about 50 to 5,000. Okuda et al. do not teach or suggest such an aspect ratio.

The present invention resulted from a recognition by the inventors that a ceramic heater containing the presently recited materials of construction is capable of maintaining better temperature control.

If the substrate of a ceramic substrate is made too thin, the distance between the heating body and the substance to be heated becomes too close. As a result, the pattern of the heating body is reflected to the heating surface of the substrate and thus uniform heating of the wafer is impossible. The present invention solves the above drawback of reflecting the heating body pattern to the heating surface by using ceramics (nitride ceramic or carbide ceramic) which have a high thermal conductivity (thermal diffusion becomes fast). Exemplary materials of construction are A1N and SiC.

In order to obtain uniform heating, the present invention uses the substrate as a thermal diffusion plate by separating the heating body from the heating surface as much as possible. As a result, in one aspect of the claimed invention, the heating body is formed on a surface opposite to the support surface positioning a semiconductor wafer as the substance to be heated. That is, such an arrangement of the heating body (arranged on the surface of the substrate opposite to the heating surface) allows the substrate to be made thin, thus improving thermal diffusion, whereby the material having a high thermal conductivity can be utilized as the substrate.

As mentioned above, the present invention resides in the use of a ceramic having a high thermal conductivity, such as A1N or SiC, as the materials of construction for the substrate. As a result, in one embodiment of the present invention, the substrate itself acts as a plate for conducting thermal diffusion from the heating body to the semiconductor wafer located on the heating surface opposite to the surface provided with the heating body. In other words, according to the present invention, the thermal diffusion is excellent owing to the material having a high thermal conductivity and the heating body is formed on the surface of the substrate opposite to the surface positioning the

semiconductor wafer, so that the distance of ensuring the sufficient thermal diffusion for uniform heating or distance between the heating surface and the heating body can be ensured without thickening the ceramic substrate(as the substrate becomes thin, thermal capacity becomes small).

The Examiner's attention is called to the fact that Okuda et al. merely disclose a heater wherein the heating body is formed in the inside or on the surface of the substrate made of a nitride of silicon or aluminum. Even if the heating body is formed on the surface of the substrate, as shown in Fig. 2 of Okuda et al., the substance to be heated is heated by the heating body because the heating efficiency is excellent, but the temperature distribution is not uniform. Temperature distribution of the heater of the present invention is uniform. As opposed to the present claimed invention, Okuda et al., Figs. 2, 3 and 5, disclose only a quadrangle-shaped heater, and not a disc-shaped heater, as recited in the present claims. Thus, the temperature drops down at the corner parts of the outer periphery and the temperature uniformity of the heating surface and the like can not be expected.

As noted above, Okuda et al. do not disclose a disc-shaped heater. Okuda et al., column 1, lines 5 to 10, teach that their heater can be widely used for ordinary houses, electronic parts, industrial equipments and automobiles. The ordinary house heater is basically quadrangle in shape as seen from petroleum fan heater, air conditioner and the like. And also, the electronic parts, printed wiring boards, and LSI are basically quadrangle in shape. Thus, the heater contemplated by Okuda et al. is quadrangle in shape, as opposed to the present claims which recite a disc-shaped heater.

The Examiner's attention is also directed to the fact that a heater having a quadrangle shape is normally used for heating a wide area rather than using a heater having a disc-shape. For example,

an area of a disc having a diameter of 10 cm is 78.5 cm^2, whereas an area of a square having a side of 10 cm is 100 cm^2. Thus, Applicants submit that the heater using a square having four corners is disclosed by Okuda et al.

As previously mentioned, the present invention provides for temperature uniformity of the heating surface and ensures the temperature uniformity of the heating surface by using a ceramic heater having a disc shape. This is entirely different and not taught or suggested by Okuda et al., which teach the use of a heater having a quadrangle shape.

Further, Okuda et al, column 2, lines 15 to 38, are concerned with improving thermal shock resistance, prevent braking and control scattering of resistance and TCR (change ratio of resistance), i.e., improving the heat-generating resistor itself, but not improving the shape of the ceramic substrate itself.

For the foregoing reasons, Applicants respectfully submit that Okuda et al. do not render obvious the claimed invention, since Okuda et al. contain no recognition of a disc-shaped ceramic heater.

For the foregoing reasons, Applicants respectfully request that the Examiner withdraw the rejection.

CONCLUSION

For the reasons advanced above, Applicants respectfully submit that all pending claims patentably define Applicants' invention. Allowance of the application with an early mailing date of the Notice of Allowance and allowability is therefore respectfully requested.

Should the Examiner have any further comments or questions, the Examiner is invited to contact the undersigned at the below-listed telephone number.

Respectfully submitted,
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APPENDIX

MARKED-UP COPY OF CHANGES TO SPECIFICATION AND CLAIMS

Marked-up copy of the first full paragraph of page 1, lines 3 to 10:

BACKGROUND OF THE INVENTION

1. Field of the Invention [TECHNICAL FIELD]

This invention relates to a ceramic heater used for drying in a semiconductor industry, and more particularly to a ceramic heater facilitating temperature control, which is [and being] thin and light, and a method of producing the same as well as an electrically conductive paste used for the formation of a heating element of the heater.

Marked-up copy of the second full paragraph of page 1, lines 11 to 19:

2. Discussion of Background Information [BACKGROUND ART]

Typical semiconductor products are manufactured by applying an etching resist onto a silicon wafer and then etching [it]. In this case, a photosensitive resin is applied onto the surface of the silicon wafer [should be] and is dried after the application. [As a drying method, it is general to place the] The resin coated silicon wafer [coated with the resin] is generally placed on a heater [and then conduct the heating] in order to dry the coating.

Marked-up copy of the paragraph bridging pages 2 and 3, i.e., page 2, line 23 to page 3, line 9:

[DISCLOSURE OF THE INVENTION]

SUMMARY OF THE INVENTION

[As a result of examinations on the above problem included in the conventional technique, the inventors noticed that] The present invention relates to a ceramic material having an excellent heat conductivity[, particularly]. In particular, a nitride ceramic or carbide ceramic is used as a substrate for a heater instead of [the] a metal such as aluminum or the like. [There is found out a discovery] It was discovered that such a ceramic substrate does not cause warping or strain even when [it] the substrate is made thin [and]. The ceramic substrate can rapidly and easily conduct [the] temperature [control] and [particularly it] is excellent in [the responsibility when] controlling the temperature [control is carried out] by changing [a] voltage or current applied to the heating body.

Marked-up copy of the sixth full paragraph of page 7, lines 18 to 20:

[BRIEF DESCRIPTION OF THE DRAWINGS]

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of a ceramic heater according to the present invention;

Marked-up copy of the third full paragraph of page 8, lines 8 to 16:

[BEST MODE FOR CARRYING OUT THE INVENTION]

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The ceramic heater according to the present invention is a heater [wherein] comprising a ceramic substrate made of an insulative nitride ceramic or carbide ceramic [is used] and a heating body [is] formed on one surface of the ceramic substrate by printing and the other surface thereof [is] being used as a heating face for heating a semiconductor product such as silicon wafer or the like placed thereon.

Marked-up copy of the first full paragraph of page 37, lines 1 to 6:

[INDUSTRIAL APPLICABILITY]

As mentioned above, the ceramic heater according to the present invention is thin, [and] light, and practical and is particularly [used] useful for heating and drying semiconductor products in the field of semiconductor industry.

MARKED-UP COPY OF CHANGES TO CLAIMS

Marked-up copy of claim 1:

1. (Amended) A ceramic heater comprising:

a disc-shaped ceramic substrate made of [a] nitride ceramic or [a] carbide ceramic, [and]

a heating body [arranged] formed on a surface [thereof] of the disc-shaped ceramic substrate, and

a surface opposite the surface having the heating body being a heating surface.

Marked-up copy of claim 3:

3. (Amended) The ceramic heater according to claim 1,

wherein the heating body [is made of] comprises a sintered body of metal particles.

Marked-up copy of claim 4:

4. (Amended) The ceramic heater according to claim 1,

wherein the heating body [is made of a mixture sintered body of] comprises metal particles and [a] metal oxide.

Marked-up copy of claim 5:

5. (Twice Amended) The ceramic heater according to claim [1] 3,

wherein [as] the metal particles [is used] are at least one [or more] of noble metal, lead, tungsten, molybdenum and nickel.

Marked-up copy of claim 7:

7. (Twice Amended) The ceramic heater according to claim 1,

wherein the heating body has [a sectional shape that] an aspect ratio at a section of the heating body [(width of heating body/thickness of heating body) is 10~10000] of about 10 to 10,000.

Marked-up copy of claim 14:

14. (Amended) A method of producing a ceramic heater according to claim 1, the method comprising [which comprises at least following steps ~]:

[step of] sintering nitride ceramic powder or carbide ceramic powder to form [a] the substrate made of nitride ceramic or carbide ceramic;

[step of] printing an electrically conductive paste on the substrate; and

[step of] sintering the electrically conductive paste by heating to form [a] the heating body on the surface of the ceramic substrate.

Marked-up copy of claim 15:

15. (Amended) The method according to claim 14, wherein the electrically conductive paste [used in the step] is a mixed paste of metal particles and [a] metal oxide.

Marked-up copy of claim 16:

16. (Amended) The method according to claim 14, [wherein a metal coating layer is formed by] further comprising plating a non-oxidizing metal onto the surface of the resulting heating body [as a post step of the step].